FLORISTICS OF XERIC SANDYLANDS IN THE POST OAK SAVANNA REGION OF EAST TEXAS

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ABSTRACT

This study describes the floristics, soils, and small-scale species richness of xeric sandylands of the post oak savanna region of east central Texas and maps the distribution of xeric sandylands throughout the West Gulf Coastal Plain. The interrelation of xeric sandylands to wetlands and their interest for regional conservation assessment are discussed.

KEY WORDS: xeric sandylands, Post Oak Savanna, flora, Texas, Gus Engeling Wildlife Management Area.

RESUMEN

En este estudio se describe la florística, suelos, y riqueza de especies a pequeña escala de los lugares arenosos xéricos de la región de sabana post oak del centro este de Texas y se cartografía la distribución de los lugares arenosos xéricos de la llanura costera del West Gulf. Se discuten la interrelación de los lugares arenosos xéricos con los humedales y su interés para la evaluación de la conservación regional.

INTRODUCTION

During the past few years, we have been studying wetlands (muck bogs, upland marshes, baygalls, and seeps) in the post oak savanna region of east central Texas and southeastern Oklahoma (Nesom et al. 1997; MacRoberts & MacRoberts 1998b). These wetlands appear to be associated with xeric sandylands (variously referred to as oak-farkleberry sandylands [Ajilvsgi 1979], Post Oak-Black Hickory Series [Diamond et al. 1987], xeric sandylands [MacRoberts & MacRoberts 1994, 1995, 1996], Grossarenic Dry Uplands [Turner et al. 1999], Sand Post Oak - Bluejack Oak Alliance [Singhurst et al. 2000], and *Quercus incana* woodland alliance [Hoagland 2000]). These deep sands act as a reservoir or sponge holding water that feeds adjacent seeps and springs that are the headwaters for the area's wetlands and ultimately the streams and rivers. These upslope soils are porous and drain readily; rainwater percolates through the sand and moves down a gradient created by underlying impermeable or slowly permeable clays. Eventually, water seeps laterally out of the hillside (Martin & Smith 1991; Jones & Carpenter 1995; Drewa 1999; Summer 1999).

As part of our study of muck bogs, upland marshes, and their flora, we studied these adjacent xeric sandylands since they are clearly the water source for these wetlands.

The primary objectives of this paper are to describe: 1) the distribution of xeric sandylands throughout the West Gulf Coastal Plain, 2) the floristics of this community in the post oak savanna region, 3) the small-scale species richness of this community, and 4) the soils upon which this community occurs.

In addition to our primary objectives for studying this community, we also are stimulated by a recent spate of national and regional conservation assessments (e.g., Diamond et al. 1997; Ricketts et al. 1999a, 1999b; Myers et al. 2000) that propose to pinpoint ecological "hotspots." These assessments are based on diversity, species richness, endemism, endangered species, and unique habitat availability. But, as is so often the case with such large-scale efforts, while some regions are well known, others are not. The post oak savanna region of east Texas is one of the poorest known. This is evident upon examining recent regional descriptions of the area (e.g., McNab & Avers 1994; Keys et al. 1995; Ricketts et al 1999a), where numerous factual errors lead to inaccurate assessments of the region's ecological "temperature."

THE SETTING

In Texas, the post oak savanna region (Fig. 1), consisting of about 30,000 sq. km, is gently rolling and hilly with elevations from 90 to 250 meters. Rainfall ranges from 75 to 115 centimeters. The Carrizo Sands are virtually coterminous with the region (McBryde 1933). Prairies are scattered throughout, notably in the south where some prairies are large (Smeins & Diamond 1983). The predominant floristic character of the region is southeastern without pines (Smeins & Diamond 1986). The area contains a diversity of plant communities, from hillside pitcher plant bogs, peat bogs, and upland marshes to open xeric sandylands and oak-hickory forests and woodlands. Characteristic communities within the post oak savanna region also occur to the east within the pineywoods (Marietta & Nixon 1983; Ward & Nixon 1992). How the post oak savanna region relates biotically to other regions in the area has yet to be studied in detail (Monk et al. 1990; Bryant et al. 1993; Skeen et. al. 1993); however, it appears to be floristically similar to adjoining regions (MacRoberts & MacRoberts pers. obs.) and has no vertebrate endemism (Telfair 1999).

McBryde (1933) conducted the only major floristic/edaphic study of the region. Subsequently, very little research has been done on the post oak savanna except for the inclusion prairies in its southern portion (Smeins & Diamond 1986).

Xeric sandylands are (or at least once were) very common in the Texas post oak savanna region, but they also occur in the pineywoods regions of southeastern Oklahoma, southwestern Arkansas, western Louisiana, eastern Texas,

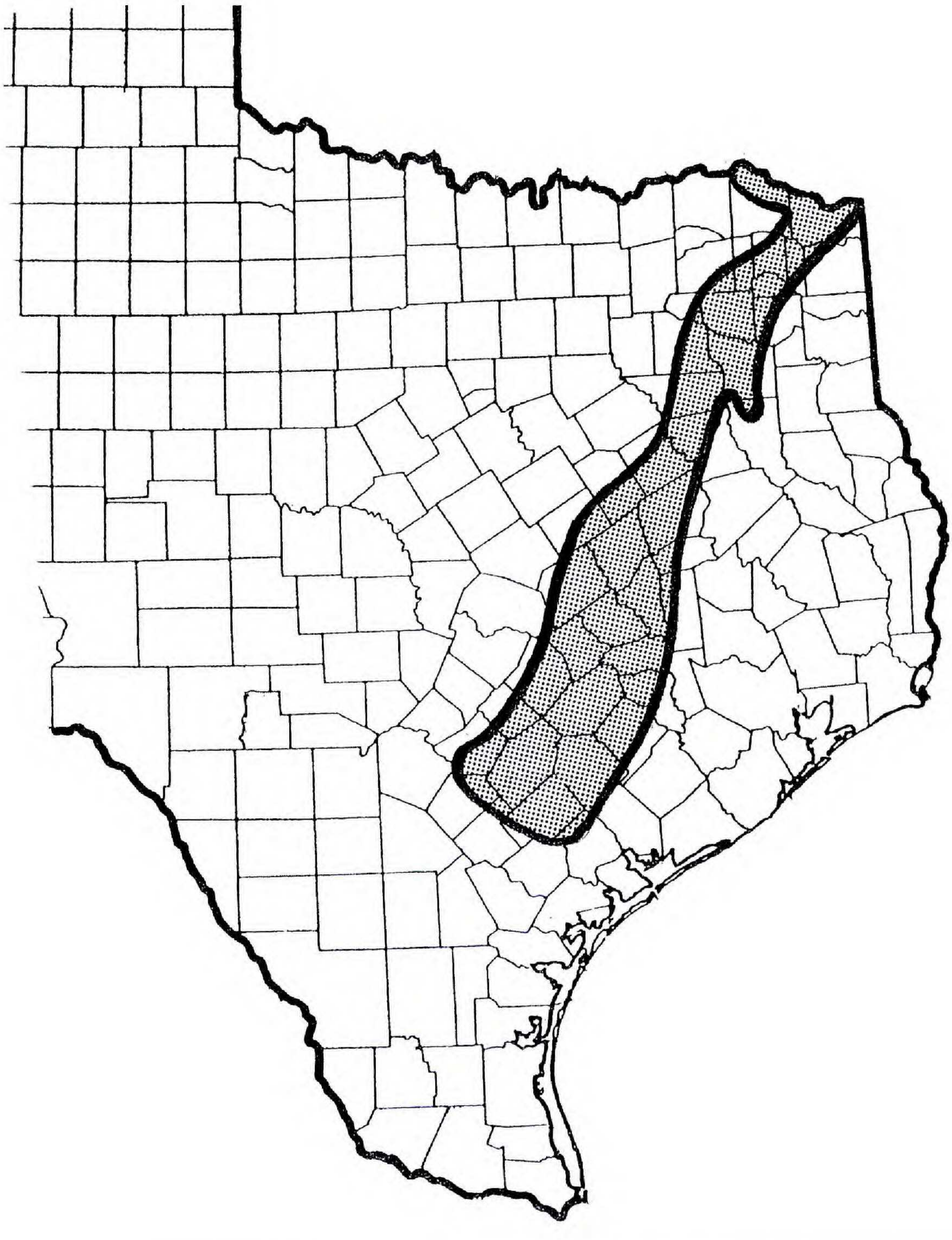

Fig. 1. Post oak savanna region of Texas.

and into the Coastal Bend of Texas (McBryde 1933; Jones 1977; Drawe et al. 1978; Taylor & Taylor 1978; Ajilvsgi 1979; Marks & Harcombe 1981; Louisiana Natural Heritage 1988; Bridges & Orzell 1989; Harcombe et al. 1993; Foti et al. 1994; MacRoberts & MacRoberts 1994, 1995, 1996; Jones & Carpenter 1995; Texas Natural Heritage Program 1995; Turner et al. 1999; Hoagland 2000). Homologues of xeric sandylands occur east of the Mississippi River (Stout & Marion 1993). It is generally assumed that oak savannas and xeric sandylands, like prairies, are kept open largely by fire (Smeins & Diamond 1986; Cutter & Guyette 1994). While encroachment of woody vegetation is ubiquitous in the absence of fire, there are many areas that remain open even when fire is suppressed, suggesting that edaphic conditions play an integral role. Characteristic tree species of xeric sandylands include *Quercus incana* W. Bartram, *Q. margarettiae* Ashe ex Small, *Q. stellata* Wangenh., and *Carya texana* Buckley, and a variety of fidel herbaceous species (see Methods for list). The area appears to be rich in plant endemism (Sorrie & Weakley 2001), and a large number of West Gulf Coastal Plain endemics are associated with this community, for example, *Brazoria truncata* (Benth.) Engelm. & A. Gray, *Palafoxia reverchonii* (Bush) Cory, *Paronychia drummondii* Torr. & A. Gray, *Pediomelum hypogaeum* (Nutt. ex Torr. & A. Gray) var. *subulatum* (Bush) J. W. Grimes, *Penstemon murrayanus* Hook., *Polanisia erosa* (Nutt.) H.H. Iltis, *Rhododon ciliatus* (Benth.) Epling, *Tetragonotheca ludoviciana* (Torr. & A. Gray) A. Gray ex Hall, *Tradescantia reverchonii* Bush, and *T. subacaulis* Bush.

METHODS

In order to develop an objective idea of the distribution of xeric sandylands, we selected 42 fidel species from the total list of species occurring in this community. We mapped these by county and parish over their ranges (Fig. 2). In the map, the number of fidels per county or parish is indicated in the legend. Parishes or counties with fewer than 10 species are left blank.

The 42 species chosen were *Astragalus leptocarpus* Torr. & A. Gray, *A. soxmaniorum* Lundell, *Berlandiera pumila* (Michx.) Nutt., *Brazoria truncata*, *Clematis reticulata* Walter, *Cnidoscolus texanus* (Muell.-Arg.) Small, *Coreopsis intermedia* Sherff, *Crataegus uniflora* Muenchh., *Croton argyranthemus* Michx., *Cyperus grayioides* Mohlenbrock, *Dalea phleoides* (Torr. & A. Gray) Shinners, *D. villosa* (Nutt.) Spreng., *Eriogonum longifolium* Nutt., *E. multiflorum* Benth., *Froelichia floridana* (Nutt.) Moq. (not distinguished from *F. gracilis* [(Hook.) Moq.]), *Hymenopappus artemisiifolius* DC., *Lithospermum caroliniense* (Walter ex J.F. Gmel.) MacMill., *Loeflingia squarrosa* Nutt., *Matelea cynanchoides* (Engelm.) Woodson, *Minuartia drummondii* (Shinners) McNeill, *Palafoxia hookeriana* Torr. & A. Gray, *P. reverchonii*, *Paronychia drummondii*, *Pediomelum digitatum* (Nutt. ex Torr. & A. Gray) Isely, *P. hypogaeum* var. *subulatum*, *Penstemon murrayanus*, *Phacelia strictiflora* (Engelm. & A. Gray) A. Gray, *Phlox drummondii* Hook., *Physalis mollis* Nutt., *Polanisia erosa* (Nutt.) H.H. Iltis, *Polygonella americana* (Fisch. & C.A. Mey.) Small, *Prunus gracilis* Engelm. & A. Gray, *Rhododon ciliatus*, *Selaginella arenicola* Underwood ssp. *riddellii* (Van Eselt.) R. M. Tryon, *Scutellaria cardiophylla* Engelm. & A. Gray, *Streptanthus*

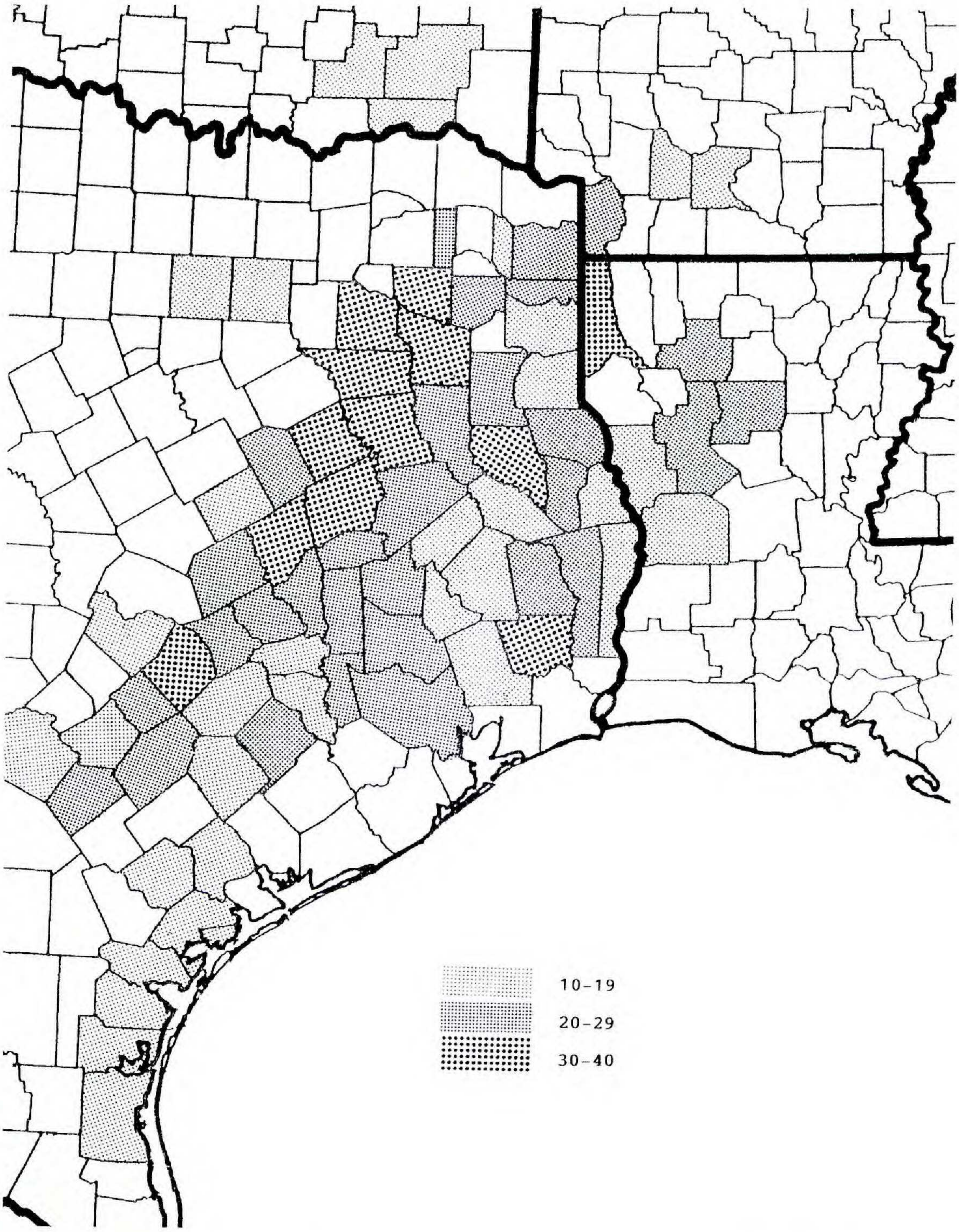

Fig. 2. Xeric sandylands species distribution (see text for key).

hyacynthoides Hook., *Stylisma pickeringii* (Torr. ex M.A. Curtis) A. Gray, *Talinum rugospermum* Holz., *Tetragonotheca ludoviciana*, *Tradescantia reverchonii*, *Yucca louisianensis* Trel., and *Zornia bracteata* J.F. Gmel. Sources for this information consisted of extensive herbarium searches, notably LSU, TAMU (both on line), ASTC, BRIT, Corpus Christi Museum of Science and History, LSUS, SBSC, SHST, TEX, VDB, WWF, atlases (e.g., Smith 1988; Thomas & Allen 1993-1998; Turner in press), and a variety of literature (e.g., Jones 1977; Taylor & Taylor 1978; Singhurst 1996; Turner 1996; Nesom & Brown 1998) and unpublished sources (Billie Turner pers. comm.; Bruce Hoagland pers. comm.). We also made field searches throughout the West Gulf Coastal Plain to look for the species and the community *in situ*.

We surveyed the flora of xeric sandylands at Gus Engeling Wildlife Management Area (GEWMA), Anderson County, Texas, in the center of the post oak savanna region. The GEWMA occurs in the central part of the Trinity River drainage along Catfish Creek (Telfair 1988). This property consists of approximately 44 sq. km, of which 18 are the sand post oak-bluejack oak community (Singhurst et al. 2000). We established a single study plot measuring 50 m × 100 m (0.5 ha), within which was another single plot measuring 20 m × 50 m (0.1 ha) with two nested 3.16 m × 3.16 m plots (0.001 ha) and 6 nested 1 m × 1 m plots (0.0001 ha) in an opening in this community (see Peet et al. 1998 for plot design). The larger plot ran parallel to the topographic gradient and the adjacent downslope bog and was about 100 meters north of the edge of the bog and a few meters higher than the bog (see MacRoberts & MacRoberts 1998b, 1999; Singhurst et al. 2000 for a description of Andrew's Bog, GEWMA). We surveyed this area monthly from March to October 2000 and listed all plant species in each plot. This gave us information on both total floristics and species/area measures for comparison with similar measures from other plant communities. We estimated ground cover and measured vegetation height in the 0.0001 ha plots. We also surveyed several other xeric sandylands in other parts of the GEWMA. Plant nomenclature throughout this paper follows Kartesz and Meacham (1999). Voucher specimens are deposited at TEX.

We collected soil samples from the upper 15 cm of the two 0.001 ha plots and from the 0.1 ha plot for comparison with this community elsewhere in its range. These were analyzed by A & L Laboratories, Memphis, Tennessee. The soil at the study site is described as deep, well-drained acidic sandy Pleistocene terraces (Arenosa series, Typic Quartzipsammeents, Entisols) (Coffee 1975).

RESULTS

Figure 1 shows the location of the Post Oak Savanna region of East Texas in which xeric sandylands are located. Figure 2 shows the frequency of occurrence of the 42 xeric sandyland fidel species in parishes and counties in the West Gulf Coastal Plain. Counties and parishes with fewer than 10 species are left blank. Table 1 lists the species found within the 0.1 ha plot. Table 2 gives additional species in the 0.5 ha plot. Table 3 shows the number of species occurring in the 0.0001 ha, 0.001 ha, 0.1 ha, and 0.5 ha plots. Table 4 gives the ground cover and vegetation height in the six 0.0001 ha plots in May and August. Table 5 gives the soil information from the study plots.

Table 1. Species present in the 0.1 ha study plot at the Gus Engeling Wildlife Management Area (Anderson County, Texas).

AGAVACEAE: *Yucca louisianensis* Trel.
AMARANTHACEAE: *Froelichia floridana* (Nutt.) Moq.
ANACARDIACEAE: *Rhus aromatica* Aiton, *Toxicodendron radicans* (L.) Kuntze
APIACEAE: *Spermolepis divaricata* (Walter) Raf. ex Ser., *S. inermis* (Nutt. ex DC.) Mathias & Constance
AQUIFOLIACEAE: *Ilex vomitoria* Sol. in Aiton
ASCLEPIADACEAE: *Matelea cynanchoides* (Engelm.) Woods
ASTERACEAE: *Croptilon divaricatum* (Nutt.) Raf., *Evax candida* (Torr. & A. Gray) A. Gray, *Helianthus debilis* Nutt. ssp. *cucumerifolia* (Torr. & A. Gray) Heiser, *Krigia virginica* (L.) Willd., *Palafoxia reverchonii* (Bush) Cory, *Pyrrhopappus carolinianus* (Walter) DC., *Senecio ampullaceus* Hook., *Thelesperma filifolium* (Hook.) A. Gray
BRASSICACEAE: *Lepidium virginicum* L., *Streptanthus hyacinthoides* Hook.
CACTACEAE: *Opuntia humifusa* (Raf.) Raf.
CAPPARACEAE: *Polanisia erosa* (Nutt.) H. H. Iltis
CARYOPHYLLACEAE: *Loeflingia squarrosa* Nutt., *Paronychia drummondii* Torr. & A. Gray
CISTACEAE: *Helianthemum georgianum* Chapm., *Lechea mucronata* Raf., *L. tenuifolia* Michx.
COMMELINACEAE: *Commelina erecta* L., *Tradescantia reverchonii* Bush, *T. subacaulis* Bush
CONVOLVULACEAE: *Stylisma pickeringii* (Torr. ex M.A. Curtis) A. Gray
CRASSULACEAE: *Sedum nuttallianum* Raf.
CUPRESSACEAE: *Juniperus virginiana* L.
CYPERACEAE: *Carex cephalophora* Muhl. ex Willd., *C. retroflexa* Muhl. ex Willd., *Cyperus grayioides* Mohlenbrock
EUPHORBIACEAE: *Cnidoscolus texanus* (Muell.-Arg.) Small, *Croton argyranthemus* Michx., *C. capitatus* Michx., *C. glandulosus* L., *C. michauxii* G.L. Webster
FABACEAE: *Astragalus leptocarpus* Torr. & A. Gray, *Baptisia nuttalliana* Small, *Centrosema virginiana* (L.) Benth., *Chamaecrista fasciculata* (Michx.) Greene, *Dalea phleoides* (Torr. & A. Gray) Shinners, *Indigofera miniata* Ortega, *Mimosa nuttallii* (DC.) B.L. Turner, *Pediomelum digitatum* (Nutt. ex Torr. & A. Gray) Isely
FAGACEAE: *Quercus incana* W. Bartram, *Q. margarettiae* Ashe ex Small
HYDROPHYLLACEAE: *Phacelia strictiflora* (Engelm. & A. Gray) A. Gray
KRAMERIACEAE: *Krameria lanceolata* Torr.
LAMIACEAE: *Brazoria truncata* (Benth.) Engelm. & A. Gray, *Monarda punctata* L., *Rhododon ciliatus* (Benth.) Epling
LILIACEAE: *Allium canadense* L.
MOLLUGINACEAE: *Mollugo verticillata* L.
ONAGRACEAE: *Oenothera laciniata* Hill
PLANTAGINACEAE: *Plantago hookeriana* Fisch. & C.A. Mey.
POACEAE: *Andropogon ternarius* Michx., *Aristida desmantha* Trin. & Rupr, *A. lanosa* Muhl. ex Elliott, *Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark, *D. oligosanthes* (Schult.) Gould, *Paspalum setaceum* Michx., *Triplasis purpurea* (Walter) Chapm., *Vulpia elliotea* (Raf.) Fernald.
POLYGONACEAE: *Eriogonum multiflorum* Benth., *Rumex hastatulus* Baldwin.
PORTULACACEAE: *Talinum rugospermum* Holz.
ROSACEAE: *Rubus argutus* Link
RUBIACEAE: *Diodia teres* Walter
SCROPHULARIACEAE: *Nuttallanthus canadensis* (L.) D.A. Sutton
SOLANACEAE: *Physalis heterophylla* Nees
VISCACEAE: *Phoradendron tomentosum* (DC.) Engelm. & A. Gray

DISCUSSION

Xeric sandylands occur from southwest Arkansas and southeastern Oklahoma to central Louisiana and the Coastal Bend of Texas. The distribution of species numbers shown in Figure 2 results in part from differential collecting: Caddo Parish and Anderson County have been well collected while most of east Texas

TABLE 2. Species in the 0.5 ha plot not found in the 0.1 ha plot. Both plots at the Gus Engeling Wildlife Management Area (Anderson County, Texas).

Bulbostylis ciliatifolia (Elliott) Fernald	*Schizachyrium scoparium* (Michx.) Nash
Carya texana Buckley	*Scleria triglomerata* Michx.
Cenchrus spinifex Cav.	*Sisyrinchium albidum* Raf.
Corydalis micrantha (Engelm. ex A. Gray) A. Gray	*Trichostema dichotomum* L.
Glandularia canadensis (L.) Nutt.	*Vaccinium arboreum* Marshall
Mirabilis albida (Walter) Heimerl	*Verbascum thapsus* L.
Oenothera heterophylla Spach	*Vitis aestivalis* Michx.
Penstemon murrayanus Hook.	*Vitis rotundifolia* Michx.

TABLE 3. Species richness in xeric sandylands at the Gus Engeling Wildlife Management Area (Anderson County, Texas).

Plot size (ha)	No. of plots	Av. no. species (range)
0.0001	6	24.5 (19–28)
0.001	2	38.5 (35–42)
0.1	1	74
0.5	1	90

has not. Better sampling would undoubtedly fill in the picture, but the outlines are clear. We have observed the community *in situ* in Miller County, Arkansas; Bienville, Caddo, Natchitoches, Vernon, and Winn parishes, Louisiana; Atoka, Choctaw, and Pushmataha counties, Oklahoma; and Anderson, Angelina, Aransas, Bastrop, Caldwell, Cass, Cherokee, Colorado, Franklin, Gonzales, Guadulape, Hardin, Henderson, Jasper, Lee, Leon, Marion, Milam, Nacogdoches, Panola, Rusk, San Augustine, San Patricio, Shelby, Smith, Tyler, Upshur, Van Zandt, Wilson, and Wood counties, Texas. We have little experience with the Coastal Bend xeric sandylands (Drawe et al. 1978), but this community appears to have affinities with the more northern and eastern xeric sandylands and needs further study. Xeric sandlylands also occur in Hopkins, Navarro, Rains, and Williamson counties and appear to have once occurred on the boundary of Fannin and Grayson counties, Texas (Jason Singhurst, pers. comm.).

There were 74 species in the 0.1 ha plot and 90 species in the 0.5 ha plot. Other taxa in xeric sandylands at GEWMA that did not occur in our plots include *Aphanostephus skirrhobasis* (DC.) Trel., *Apocynum cannabinum* L., *Asclepias amplexicaulis* Sm., *Berlandiera pumila*, *Bouteloua hirsuta* Lag., *Delphinium carolinianum* Walter, *Descurainea pinnata* (Walter) Britton, *Eragrostis secundiflora* J. Presl., *Eriogonum longifolium*, *Hymenopappus artemisiifolius*, *Liatris elegans* (Walter) Michx., *Mirabilis albida*, *Oxalis priceae* Small, *Pediomelum hypogaeum* var. *subulatum*, *Physalis turbinata* Medik., *Polygonella americana*, *Scutellaria cardiophylla*, *Selaginella arenicola* ssp. *riddellii*, *Sideroxylon lanuginosum* Michx., TABLE. 4. Ground cover and vegetation height in six 0.0001 ha plots at the Gus Engeling Wildlife Management Area (Anderson County, Texas)

Plot (month)	Average height (cm)	Tallest height (cm)	Percent cover
1 (August)	20	40	20
(May)	10	55	20
2 (August)	20	30	20
(May)	10	25	30
3 (August)	20	40	20
(May)	15	35	30
4 (August)	15	50	15
(May)	10	20	20
5 (August)	20	40	20
(May)	15	30	40
6 (August)	20	45	25
(May)	15	30	40

TABLE. 5. Soil characteristics of sample plots at the Gus Engeling Wildlife Management Area (Anderson County, Texas).

		Exchangeable ions (ppm)				
Sample	pH	P	K	Ca	Mg	Organic Matter%
1	4.9	26	27	172	18	1.0
2	4.8	21	20	97	14	0.8
3	4.4	24	18	80	10	0.8

Stillingia sylvatica Garden ex L., *Tetragonotheca ludoviciana*, *Tragia urticifolia* Michx., *Triodanis perfoliata* (L.) Nieuwl., and *Vicia ludoviciana* Nutt. (see also Singhurst et al. 2000).

The ground cover varied from about 15 percent to 40 percent throughout the growing season. Non-vegetated areas always prominently showed and vegetation was never tall. In general, biomass was low and sunlight was directly on the ground.

Species richness can be measured at many scales. At scales of 0.01 ha and larger, tropical rainforests are the most species rich. However, at scales below 0.001 ha and often 0.01 ha, temperate grasslands and open savannas of the southeastern United States are the most species rich. Values of between 20 and 40 species per 0.0001 ha occur but are very uncommon (Peet et al. 1983; Walker & Peet 1983; Peet & Allard 1993; Brewer 1998; Platt 1999). Peet et al. (1983) found that for a broad range of forest and woodland types, no community type exceeded 17 species per 0.0001 ha and none averaged over 13. Even tallgrass prairies, which were the highest, averaged only 18.

While very little information exists on species richness of West Gulf

Coastal Plain plant communties, the scant small-scale information available indicates that wetland pine savannas, bogs, and upland pine savannas average around 20 species in 0.0001 ha plots (Allen et al. 1988; MacRoberts & MacRoberts 1991, 1998a; Carr 2000).

In the light of these figures, it is interesting that the GEWMA xeric sandyland plots show higher species richness at small scales than virtually all other plant communities so far measured in the southeastern United States. These xeric sandylands also show a low "z" value (about 0.19), meaning that there is basically a species doubling for every 100-fold increase in area. In the present case, a 0.0001 ha plot contains roughly one-half of the species found in a 0.01 ha plot, and one-quarter the species found in a 1.0 ha plot (see MacArthur & Wilson 1967; Harris 1984 for discussion of "z" value).

The reason for such high species counts in these small-scale plots is not clear except that, in this case, most species are relatively diminutive with a variety of growth forms (about 60 percent of the species are perennials), and many have very brief above-ground life histories. Species packing is therefore no problem.

The role of fire in maintaining plant communities is well understood (Platt 1999). In the absence of fire, many plant communities (e.g., prairies) are rapidly invaded by shrubs and trees (Packard & Mutel 1997). Oak-hickory savannas and xeric sandylands appear to require fire for natural maintenance (Cutter & Guyette 1994). We noticed in this study that, because of the long drought that the West Gulf Coastal Plain has been experiencing, there has been a significant die-off of woody vegetation, notably in the dryer areas. Fire, therefore, may not be the only important force preventing woody invasion. Periodic droughts may be another factor keeping xeric sandylands, as well as other communities, open.

Soils at GEWMA are virtually identical to soils tested from xeric sandyland sites in Louisiana and east Texas (MacRoberts & MacRoberts 1994, 1995, 1996). They are nutrient-poor and acidic. Soil conditions per se may also preclude woody invasion.

We have emphasized the floristics of xeric sandylands largely to develop baseline information, and we note that the species richness of this community is considerably greater than generally recognized. The hydrologic and geomorphologic properties of these xeric sandhills also are significant, as the water they supply underlies the existence of adjacent wetland communities—bogs, marshes, baygalls, and seeps.

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